

Predicting Outcome (Prognosis) in Spinal Cord Injury

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What is the spinal cord?

The spinal cord is the part of the central nervous system that carries messages back and forth between the brain and the rest of the body. These messages are carried along nerve fibers and nerve cells by means of electrical impulses. Unlike other cells in the body, nerve cells cannot be replaced if they die. Therefore, it is extremely important to preserve the nerve cells that are present at birth. That is why the brain and spinal cord are surrounded by bone and are the most protected parts of the body.

Injury to the spinal cord

When the nerve cells within the spinal cord are damaged by injury or disease, they are unable to carry messages from one location to another. The damage may be permanent or temporary. If a nerve cell is bruised or swollen, it may eventually recover and resume its normal function. In this case the damage was only temporary. If a nerve cell dies, it will not grow back again or be replaced, the damage will be permanent.

All of an individual's affected nerve cells may not have the same degree of injury; that is, some cells may be temporarily damaged and others may be permanently damaged. When the spinal cord is initially damaged, it is in a state of "spinal shock" and none of the nerve cells may function. Unfortunately, there is no test at this time that will

determine whether the damage is temporary or permanent.

Only time will tell!

Complete vs. Incomplete Injury

It is often assumed that a complete injury means that the spinal cord has been cut in two. This is not true.

A complete injury is one in which no nerve messages are able to get past the injury at the time the examination is done. For example, no sensations can be felt below the injury because the messages cannot get to the brain and no voluntary movement is possible because the messages cannot get from the brain to the muscle. It is often incorrectly assumed that a complete injury means that the spinal cord has been cut in two. This is not true. If even one nerve fiber is still able to carry messages past the injured area, the injury is incomplete. Therefore, a very careful neurological examination must be done before deciding if an injury is complete or incomplete with particular emphasis on sensation in the area around the rectum which receives its nerve input from the very bottom of the spinal cord and may be the only preserved function.

Neurological Examination

For the past 30 years, detailed clinical information has been collected by the National Spinal Cord



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Injury Database from numerous spinal cord injury (SCI) centers about the SCI patients who were treated there¹. Since an individual center may see only 100 or less new patients per year, by combining the results from many centers, a larger number of injuries can be compared. As much as possible, the information has been standardized so that each center performs the evaluations the same way and collects the same information.

Careful neurological examinations are done as soon as the patient arrives at the SCI Model Center, when he or she is diagnosed or when the spinal cord injury is determined. These are repeated at regular intervals afterward - such as when the patient is transferred to rehabilitation, when discharged from rehabilitation, at one year after injury and at yearly intervals afterward as long as the patient is followed by the Center. In addition to the neurological examination, information is collected about the type of treatment given, complications that occurred, level of self-care independence, bowel and bladder management, etc.

Over 20,000 individuals have been followed so far. From an analysis of this information it is possible to determine such things as:

- What kind of recovery occurred following different degrees of injury severity at the time of the original examination.
- Long-term results of different types of treatment (including complications and outcomes).
- How long it takes to reach the maximum recovery that occurs.
- Life expectancy following different levels of injury.

Based on this type of research, doctors can make an “educated guess” about a new injury by comparing the neurological findings with previously injured individuals with the same findings. Therefore, if 99% of the similarly injured persons had no recovery or had excellent recovery, the odds are that the new injury will respond the same way. However, there is no guarantee that this will happen! The future of each new injury will only be determined by time.

The international standards for neurological classification of spinal cord injury² have been developed to classify different spinal cord injuries, and help doctors and researchers more effectively study and compare spinal cord individuals who have had a similar level of injury. Using an examination of muscle strength, sensation and a rectal exam (measuring rectal sensation and motor strength), doctors can determine your neurological level. The neurological level is named based on the last normal motor (myotome) and sensory (dermatome) level. There are:

- eight cervical levels (C1-8)
- twelve thoracic levels (T1-12)
- five lumbar levels (L1-5) and
- five sacral levels (S1-5).

The rectal exam is used to determine if the injury is a complete or incomplete spinal cord injury and assign an ASIA impairment scale (AIS). A letter designation of A to E is used to score the AIS.

- A is a complete injury with no rectal sensory or motor function.
- B is an incomplete injury with sensory function but no rectal motor function.
- C is an incomplete injury with preserved motor function below the neurological level but with weak motor return, which is not strong enough to overcome gravity.
- D is an incomplete injury with at least half the muscles below the neurological level with strength enough to overcome gravity and be of functional use.
- E is a normal recovery of sensory and motor strength.

How much recovery can I expect?

Research in the field of spinal cord injury can be used as a guideline to predict recovery following a new injury. Below is a summary of research findings related to neurorecovery. This is a very simplified summary. For further detail, see the references at the end.

- The severity of the original injury determines whether or not recovery will occur. Magnetic resonance imaging (MRI) of the

spinal cord at the time of injury has been shown to help in determining the severity of injury, and when combined with the neurologic exam it can add some value to the prediction of recovery^{3 4}. Therefore the severity and predictions must be based on what has happened to others in the past with similar neurological and radiologic findings. One neurologic finding that is associated with better recovery is the ability to tell the difference between sharp and dull sensation^{5 6}.

- Incomplete injuries have a better chance of further recovery than complete injuries, but even with incomplete injuries there is no guarantee that any further recovery will occur.
- Most of the recovery occurs early (within the first few weeks). Therefore, each day that goes by without any return of function means that the chance for recovery is less.
- No amount of hard work will make the nerves regenerate. If hard work was all it took, very few people would end up with permanent paralysis. There is extensive work and effort presently underway, to see if forced movement of the legs with aggressive bicycling and treadmill training will enhance recovery. At the present time, the data is being collected and the jury is still out. Early results suggest that it might help the subject with an incomplete injury function a little better, with sitting balance and walking speed and distance, but it has not helped the subjects with a complete injury in a way that we can measure.
- Having surgery and participating in therapy do not determine how much recovery you will have. Surgery is done to decompress any pressure on the spinal cord and the nerve roots and to restore stability to the spine. The surgery is designed to prevent further or future spinal cord compression and damage. Therapy is used for the following reasons:
 - to prevent the secondary complications of immobility, such as pneumonia, pressure sores, joint contractures and deconditioning.
 - to restore muscle mass in muscle groups with residual strength to improve functional independence using the myotomes and dermatomes that are still functional; and
 - to compensate for the denervated myotomes and dermatomes with assistive devices, orthotics and technique to maximize functional independence.
- Rehabilitation will not affect the degree of recovery. The purpose of rehabilitation is to improve function in self-care activities (such as dressing, transfers and wheelchair mobility) using preserved neurological function, which is available to improve functional independence. Since most of the neurological recovery starts within the first few weeks after injury and this is usually the same time therapy is being done, there is a tendency to think the recovery is due to the therapy. It should be clearly understood that the therapy did not cause the recovery, but the therapy will help optimize functional independence and prevent many secondary complications.
- Just because one nerve cell recovers does not mean that others will. Patients often get very excited when they see some small improvement in sensation or increase in strength, but only time will tell if anything else will come back or if the recovery will result in a change in functional abilities.
- In two recent research studies of patients with complete spinal cord injury during the first year of injury, about 70% recovered at least one motor level, but only 30% had recovered two or more motor levels, one year after the injury. Approximately 30 % converted from AIS A to incomplete AIS B at 50 to 52 weeks after the injury^{7 8}.

- There is a small degree of neurologic recovery between 1 and 5 years after a traumatic spinal cord injury. This is called “late conversion,” and studies have shown it to occur in only 5.6 % of cases from a neurologically complete injury to an incomplete injury. However, there was only a 2.1% conversion from motor complete to motor incomplete status⁹. In another study¹⁰ of complete spinal cord injury subjects, with a two-year follow up, motor recovery did not occur below the zone of injury.

Summary

No physician knows how much recovery will occur in a specific individual and there is no test currently available that will enable him/her to give an accurate prediction. Only time will tell!

The best that can be done is to make a prediction based on what has happened in the past to others with similar neurological findings at the same time since onset of the injury. But in the meantime, rehabilitation (to learn to be as functionally independent as possible and to prevent complications) offers the best opportunity to take advantage of any return, if and when it should happen!

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